

## CHAPTER 5 (Odd)

1. a.  $R_T = 2\ \Omega + 6\ \Omega + 12\ \Omega = 20\ \Omega, I = \frac{E}{R_T} = \frac{60\ \text{V}}{20\ \Omega} = 3\ \text{A}$
- b.  $R_T = 0.2\ \text{M}\Omega + 1\ \text{M}\Omega + 0.33\ \text{M}\Omega + 0.1\ \text{M}\Omega = 1.63\ \text{M}\Omega$   
 $I = \frac{E}{R_T} = \frac{10\ \text{V}}{1.63\ \text{M}\Omega} = 6.135\ \mu\text{A}$
- c.  $R_T = 15\ \Omega + 10\ \Omega + 25\ \Omega + 25\ \Omega + 10\ \Omega + 25\ \Omega = 110\ \Omega$   
 $I = \frac{E}{R_T} = \frac{35\ \text{V}}{110\ \Omega} = 318.2\ \text{mA}$
- d.  $R_T = 1.2\ \text{k}\Omega + 4.5\ \text{k}\Omega + 1.3\ \text{k}\Omega + 3\ \text{k}\Omega = 10\ \text{k}\Omega$   
 $I = \frac{E}{R_T} = \frac{120\ \text{V}}{10\ \text{k}\Omega} = 12\ \text{mA}$
3. a.  $R_T = 60\ \Omega + 1200\ \Omega + 2740\ \Omega = 4\ \text{k}\Omega$   
 $E = IR_T = (4\ \text{mA})(4\ \text{k}\Omega) = 16\ \text{V}$
- b.  $R_T = 1.2\ \Omega + 8.2\ \Omega + 4.7\ \Omega + 2.7\ \Omega = 16.8\ \Omega$   
 $E = IR_T = (250\ \text{mA})(16.8\ \Omega) = 4.2\ \text{V}$
5. a.  $R_T = 4.7\ \Omega + 5.6\ \Omega = 10.3\ \Omega$   
 $I = \frac{16\ \text{V} - 8\ \text{V} - 4\ \text{V}}{10.3\ \Omega} = \frac{4\ \text{V}}{10.3\ \Omega} = 0.388\ \text{A (clockwise)}$
- b.  $R_T = 4.7\ \Omega + 1.2\ \Omega + 5.6\ \Omega = 11.5\ \Omega$   
 $I = \frac{18\ \text{V} + 10\ \text{V} - 4\ \text{V}}{11.5\ \Omega} = 2.087\ \text{A (counterclockwise)}$
7. a.  $+10\ \text{V} - 2\ \text{V} - 3\ \text{V} - V_{ab} = 0$       b.  $60\ \text{V} + 20\ \text{V} - V_{ab} - 10\ \text{V} = 0$   
 $V_{ab} = 10\ \text{V} - 5\ \text{V} = 5\ \text{V}$        $V_{ab} = 80\ \text{V} - 10\ \text{V} = 70\ \text{V}$
9.  $I = \frac{27\ \text{V} - 9\ \text{V} - 5\ \text{V}}{2.2\ \text{k}\Omega + 1.2\ \text{k}\Omega + 0.56\ \text{k}\Omega} = \frac{13\ \text{V}}{3.96\ \text{k}\Omega} = 3.28\ \text{mA}$   
 $V_1 = IR = (3.28\ \text{mA})(2.2\ \text{k}\Omega) = 7.22\ \text{V}$
11. a.  $R_T = 22\ \Omega + 10\ \Omega + 5.6\ \Omega + 33\ \Omega = 70.6\ \Omega$   
 $I = \frac{E}{R_T} = \frac{6\ \text{V}}{70.6\ \Omega} = 0.085\ \text{A} = 85\ \text{mA (CCW)}$   
 $V_1 = IR = (85\ \text{mA})(33\ \Omega) = 2.805\ \text{V}$   
 $V_2 = IR = (85\ \text{mA})(5.6\ \Omega) = 0.476\ \text{V}$   
 $V_3 = IR = (85\ \text{mA})(10\ \Omega) = 0.850\ \text{V}$   
 $V_4 = IR = (85\ \text{mA})(22\ \Omega) = 1.870\ \text{V}$

b.  $E = V_1 + V_2 + V_3 + V_4$   
 $6 \text{ V} = 2.805 \text{ V} + 0.476 \text{ V} + 0.850 \text{ V} + 1.870 \text{ V}$   
 $6 \text{ V} \checkmark = 6 \text{ V}$

c.  $33 \Omega: P = I^2 R = (85 \text{ mA})^2 33 \Omega = 238.4 \text{ mW}$   
 $5.6 \Omega: P = I^2 R = (85 \text{ mA})^2 5.6 \Omega = 40.5 \text{ mW}$   
 $10 \Omega: P = I^2 R = (85 \text{ mA})^2 10 \Omega = 72.3 \text{ mW}$   
 $22 \Omega: P = I^2 R = (85 \text{ mA})^2 22 \Omega = 159 \text{ mW}$

$$P_{\text{del}} = EI = (6 \text{ V})(85 \text{ mA}) = 510 \text{ mW}$$

$$P_{\text{del}} = 238.4 \text{ mW} + 40.5 \text{ mW} + 72.3 \text{ mW} + 159 \text{ mW}$$

$$510 \text{ mW} \checkmark = 510 \text{ mW}$$

d. All  $\frac{1}{2} \text{ W}$ .

13. a.  $R_T = NR_1 = 8 \left[ 28\frac{1}{8} \Omega \right] = 225 \Omega$   
 $I = \frac{E}{R_T} = \frac{120 \text{ V}}{225 \Omega} = 0.533 \text{ A} = \frac{8}{15} \text{ A}$

b.  $P = I^2 R = \left[ \frac{8}{15} \text{ A} \right]^2 \left[ 28\frac{1}{8} \Omega \right] = \left[ \frac{64}{225} \right] \left[ \frac{225}{8} \right] = 8 \text{ W}$

c.  $V = IR = \left[ \frac{8}{15} \text{ A} \right] \left[ \frac{225}{8} \Omega \right] = 15 \text{ V}$

d. All go out!

15. a.  $V_{ab} = \frac{50 \Omega(100 \text{ V})}{50 \Omega + 25 \Omega} = 66.67 \text{ V}$

b.  $V_{ab} = \frac{-4 \Omega(80 \text{ V})}{4 \Omega + 6 \Omega + 10 \Omega + 20 \Omega} = \frac{-320 \text{ V}}{40} = -8 \text{ V}$

c.  $V_{ab} = \frac{(2 \text{ k}\Omega + 3 \text{ k}\Omega)(40 \text{ V})}{(4 \text{ k}\Omega + 1 \text{ k}\Omega + 2 \text{ k}\Omega + 3 \text{ k}\Omega)} = \frac{5(40 \text{ V})}{10} = 20 \text{ V}$

d.  $V_{ab} = \frac{(1.5 \Omega + 0.6 \Omega + 0.9 \Omega)(0.36 \text{ V})}{2.5 \Omega + 1.5 \Omega + 0.6 \Omega + 0.9 \Omega + 0.5 \Omega}$   
 $= \frac{(3 \Omega)(0.36 \text{ V})}{6 \Omega} = 0.18 \text{ V}$

17. a.  $12 \text{ V}$

b.  $V_3 = E - V_1 - V_2 = 40 \text{ V} - 4 \text{ V} - 12 \text{ V} = 24 \text{ V}$

c.  $\frac{V_3}{V_1} = \frac{R_3}{R_1}$  and  $R_3 = \frac{V_3}{V_1} R_1 = \frac{24 \text{ V}}{4 \text{ V}} \cdot 10 \Omega = (6)(10 \Omega) = 60 \Omega$

- d.  $I = \frac{E}{R_T} = \frac{40 \text{ V}}{10 \Omega + 30 \Omega + 60 \Omega} = \frac{40 \text{ V}}{100 \Omega} = 0.4 \text{ A}$
- e.  $R_3 = \frac{V_3}{I} = \frac{24 \text{ V}}{0.4 \text{ A}} = 60 \Omega$  (checks)
19. a.  $R_{\text{bulb}} = \frac{V}{I} = \frac{8 \text{ V}}{50 \text{ mA}} = 160 \Omega$   
 $V_{R_s} = 12 \text{ V} - 8 \text{ V} = 4 \text{ V} = \frac{R_s 12 \text{ V}}{R_s + 160 \Omega}$   
 $(R_s + 160 \Omega)4 \text{ V} = R_s 12 \text{ V}$   
 $4R_s + 640 \Omega = 12R_s$   
 $8R_s = 640 \Omega$   
 $R_s = \frac{640 \Omega}{8} = 80 \Omega$
- b.  $P = I^2 R = (50 \text{ mA})^2 80 \Omega = 0.2 \text{ W} < \frac{1}{4} \text{ W}$
21.  $R_T = \frac{V}{I} = \frac{72 \text{ V}}{4 \text{ mA}} = 18 \text{ k}\Omega$   
 $V_{R_1} = 0.2V_{R_2}$   
 $IR_1 = 0.2IR_2$   
and  $R_1 = 0.2R_2$   
but  $R_T = R_1 + R_2 = 18 \text{ k}\Omega$   
and  $0.2R_2 + R_2 = 18 \text{ k}\Omega$   
or  $R_2 = \frac{18 \text{ k}\Omega}{1.2} = 15 \text{ k}\Omega$   
with  $R_1 = 0.2R_2 = 0.2(15 \text{ k}\Omega) = 3 \text{ k}\Omega$
23. a.  $E = V_{R_1} + V_{R_2} + V_{R_3}$   
 $= V_{R_1} + 3V_{R_1} + 4V_{R_2} = V_{R_1} + 3V_{R_1} + 4(3V_{R_1}) = V_{R_1} + 3V_{R_1} + 12V_{R_1}$   
with  $E = 16V_{R_1}$   
and  $V_{R_1} = \frac{E}{16} = \frac{64 \text{ V}}{16} = 4 \text{ V}$   
 $V_{R_2} = 3V_{R_1} = 3(4 \text{ V}) = 12 \text{ V}$   
 $V_{R_3} = 4V_{R_2} = 4(12 \text{ V}) = 48 \text{ V}$   
 $R_1 = \frac{V_{R_1}}{I} = \frac{4 \text{ V}}{10 \text{ mA}} = 0.4 \text{ k}\Omega, R_2 = \frac{V_{R_2}}{I} = \frac{12 \text{ V}}{10 \text{ mA}} = 1.2 \text{ k}\Omega$   
 $R_3 = \frac{V_{R_3}}{I} = \frac{48 \text{ V}}{10 \text{ mA}} = 4.8 \text{ k}\Omega$
- b. Voltage levels remain the same  
 $R_1 = 0.4 \text{ M}\Omega, R_2 = 1.2 \text{ M}\Omega, R_3 = 4.8 \text{ M}\Omega$
25. a.  $I(\text{CW}) = \frac{120 \text{ V} - 60 \text{ V}}{6 \Omega + 3 \Omega} = \frac{60 \text{ V}}{9 \Omega} = 6.667 \text{ A}$   
 $V = IR = (6.667 \text{ A})(3 \Omega) = 20 \text{ V}$

- b.  $I(\text{CW}) = \frac{70 \text{ V} - 10 \text{ V}}{10 \Omega + 20 \Omega + 30 \Omega} = \frac{60 \text{ V}}{60 \Omega} = 1 \text{ A}$   
 $V = IR = (1 \text{ A})(10 \Omega) = 10 \text{ V}$
27.  $I = \frac{47 \text{ V} - 20 \text{ V}}{2 \text{ k}\Omega + 3 \text{ k}\Omega + 4 \text{ k}\Omega} = \frac{27 \text{ V}}{9 \text{ k}\Omega} = 3 \text{ mA (CCW)}$   
 $V_{2\text{k}\Omega} = 6 \text{ V}, V_{3\text{k}\Omega} = 9 \text{ V}, V_{4\text{k}\Omega} = 12 \text{ V}$
- a.  $V_a = 20 \text{ V}, V_b = 20 \text{ V} + 6 \text{ V} = 26 \text{ V}, V_c = 20 \text{ V} + 6 \text{ V} + 9 \text{ V} = 35 \text{ V}$   
 $V_d = -12 \text{ V}, V_e = 0 \text{ V}$
- b.  $V_{ab} = -6 \text{ V}, V_{dc} = -47 \text{ V}, V_{cb} = 9 \text{ V}$
- c.  $V_{ac} = -15 \text{ V}, V_{db} = -47 \text{ V} + 9 \text{ V} = -38 \text{ V}$
29.  $V_0 = 0 \text{ V}$   
 $V_4 = -12 \text{ V} + 2 \text{ V} = 0, V_4 = +10 \text{ V}$   
 $V_7 = 4 \text{ V}$   
 $V_{10} = 20 \text{ V}$   
 $V_{23} = +6 \text{ V}$   
 $V_{30} = -8 \text{ V}$   
 $V_{67} = 0 \text{ V}$   
 $V_{56} = -6 \text{ V}$   
 $I = \frac{V_4}{4 \Omega} = \frac{V_{23}}{4 \Omega} = \frac{6 \text{ V}}{4 \Omega} = 1.5 \text{ A} \uparrow$
31.  $R_{\text{int}} = \frac{V_{NL}}{I} - R_L = \frac{60 \text{ V}}{2 \text{ A}} - 28 \Omega = 2 \Omega$
33.  $R_{\text{int}} = \frac{V_{NL}}{I} - R_L = \frac{6 \text{ V}}{10 \text{ mA}} - 500 \Omega = 100 \Omega$
35.  $VR\% = \frac{R_{\text{int}}}{R_L} \times 100\% = \frac{0.05 \Omega}{3.3 \Omega} \times 100\%$   
 $= 1.52\%$

## CHAPTER 5 (Even)

2. a.  $R_T = 30\ \Omega = 10\ \Omega + 12\ \Omega + R$   
 $R = 8\ \Omega$   
 $I = \frac{E}{R_T} = \frac{30\ \text{V}}{30\ \Omega} = 1\ \text{A}$
- b.  $R_T = 60\ \text{k}\Omega = 12.6\ \text{k}\Omega + R + 0.4\ \text{k}\Omega + 45\ \text{k}\Omega$   
 $R = 2\ \text{k}\Omega$
- c.  $R_T = 220\ \Omega = 50\ \Omega + R_1 + 60\ \Omega + R_1 + 10\ \Omega$   
 $220\ \Omega = 120\ \Omega + 2R_1$   
 $R_1 = 50\ \Omega = R_2$   
 $I = \frac{E}{R_T} = \frac{120\ \text{V}}{220\ \Omega} = 0.5455\ \text{A}$
- d.  $R_T = 1600\ \text{k}\Omega = 200\ \text{k}\Omega + 56\ \text{k}\Omega + 100\ \text{k}\Omega + R$   
 $R = 1,224\ \text{k}\Omega = 1.244\ \text{M}\Omega$   
 $I = \frac{E}{R_T} = \frac{50\ \text{V}}{1.6\ \text{M}\Omega} = 31.25\ \mu\text{A}$
4. a.  $I = \frac{12\ \text{V}}{2\ \Omega} = 6\ \text{A}$   
 $R_T = 16\ \Omega = 5\ \Omega + 2\ \Omega + R$   
 $R = 9\ \Omega$   
 $V_{5\Omega} = (I)(5\ \Omega) = (6\ \text{A})(5\ \Omega) = 30\ \text{V}$   
 $V_{9\Omega} = (I)(9\ \Omega) = (6\ \text{A})(9\ \Omega) = 54\ \text{V}$   
 $E = 30\ \text{V} + 12\ \text{V} + 54\ \text{V} = 96\ \text{V}$
- b.  $P = I^2 R \Rightarrow I = \sqrt{\frac{P}{R}} = \sqrt{\frac{79.2\ \text{mW}}{2.2\ \text{k}\Omega}} = \sqrt{36 \times 10^{-6}}$   
 $= 6 \times 10^{-3}\ \text{A} = 6\ \text{mA}$   
 $R = \frac{V}{I} = \frac{9\ \text{V}}{6\ \text{mA}} = 1.5\ \text{k}\Omega$   
 $V_{3.3\text{k}\Omega} = IR = (6\ \text{mA})(3.3\ \text{k}\Omega) = 19.8\ \text{V}$   
 $V_{2.2\text{k}\Omega} = IR = (6\ \text{mA})(2.2\ \text{k}\Omega) = 1.32\ \text{V}$   
 $E = 1.32\ \text{V} + 9\ \text{V} + 19.8\ \text{V} = 30.12\ \text{V}$
6. a.  $P = I^2 R \Rightarrow R = \frac{P}{I^2} = \frac{100\ \text{mW}}{(5\ \text{mA})^2} = 4\ \text{k}\Omega$   
 $I(\text{CW}) = 5\ \text{mA} = \frac{E + 20\ \text{V}}{5\ \text{k}\Omega + 4\ \text{k}\Omega}$   
 $E + 20\ \text{V} = 5\ \text{mA}(9\ \text{k}\Omega) = 45\ \text{V}$   
 $E = 45\ \text{V} - 20\ \text{V} = 25\ \text{V}$

- b.  $I = \frac{16 \text{ V}}{2 \text{ k}\Omega} = 8 \text{ mA}$ ,  $R = \frac{12 \text{ V}}{I} = \frac{12 \text{ V}}{8 \text{ mA}} = 1.5 \text{ k}\Omega$   
 $I(\text{CCW}) = 8 \text{ mA} = \frac{E - 8 \text{ V} - 6 \text{ V}}{2 \text{ k}\Omega + 1.5 \text{ k}\Omega}$   
 $E - 14 \text{ V} = 8 \text{ mA}(3.5 \text{ k}\Omega) = 28 \text{ V}$   
 $E = 28 \text{ V} + 14 \text{ V} = 42 \text{ V}$
8. a.  $V_2 = +10 \text{ V}$   
KVL:  $+10 \text{ V} - 6 \text{ V} - V_1 = 0$   
 $V_1 = 4 \text{ V}$
- b. KVL:  $24 \text{ V} - 10 \text{ V} - V_1 = 0$   
 $V_1 = 14 \text{ V}$   
 $10 \text{ V} - V_2 + 6 \text{ V} = 0$   
 $V_2 = 10 \text{ V} + 6 \text{ V} = 16 \text{ V}$
10. a.  $R_T = 3 \text{ k}\Omega + 1 \text{ k}\Omega + 2 \text{ k}\Omega = 6 \text{ k}\Omega$       b.  $E = V_1 + V_2 + V_3$   
 $I = \frac{E}{R_T} = \frac{120 \text{ V}}{6 \text{ k}\Omega} = 20 \text{ mA}$        $120 \text{ V} \checkmark = 60 \text{ V} + 20 \text{ V} + 40 \text{ V} = 120 \text{ V}$   
 $V_1 = IR_1 = (20 \text{ mA})(3 \text{ k}\Omega) = 60 \text{ V}$   
 $V_2 = IR_2 = (20 \text{ mA})(1 \text{ k}\Omega) = 20 \text{ V}$   
 $V_3 = IR_3 = (20 \text{ mA})(2 \text{ k}\Omega) = 40 \text{ V}$
- c.  $P_1 = V_1 I = (60 \text{ V})(20 \times 10^{-3} \text{ A}) = 1.2 \text{ W}$   
 $P_2 = V_2 I = (20 \text{ V})(20 \text{ mA}) = 0.4 \text{ W}$   
 $P_3 = V_3 I = (40 \text{ V})(20 \text{ mA}) = 0.8 \text{ W}$   
 $P_{\text{del}} = EI = (120 \text{ V})(20 \text{ mA}) = 2.4 \text{ W}$   
 $P_{\text{del}} = P_1 + P_2 + P_3$   
 $2.4 \text{ W} \checkmark = 1.2 \text{ W} + 0.4 \text{ W} + 0.8 \text{ W} = 2.4 \text{ W}$
- d.  $R_1 \Rightarrow 2 \text{ W}$ ,  $R_2 \Rightarrow \frac{1}{2} \text{ W}$ ,  $R_3 \Rightarrow 1 \text{ W}$
12. a.  $V = 120 \text{ V} - 80 \text{ V} = 40 \text{ V}$   
 $I = \frac{40 \text{ V}}{20 \Omega} = 2 \text{ A}$   
 $R = \frac{V}{I} = \frac{80 \text{ V}}{2 \text{ A}} = 40 \Omega$
- b.  $I = \frac{8 \text{ V}}{2.2 \Omega} = 3.636 \text{ A}$   
 $V_1 = I(4.7 \Omega) = 17.09 \text{ V}$   
 $V_2 = I(6.8 \Omega) = 24.73 \text{ V}$
- c.  $P = I^2 R \Rightarrow R = P/I^2 = 21 \text{ W}/(1 \text{ A})^2 = 21 \Omega$   
 $V_1 = IR = (1 \text{ A})(2 \Omega) = 2 \text{ V}$   
 $V_2 = IR = (1 \text{ A})(1 \Omega) = 1 \text{ V}$   
 $V_3 = IR = (1 \text{ A})(21 \Omega) = 21 \text{ V}$   
 $E = V_1 + V_2 + V_3 = 2 \text{ V} + 1 \text{ V} + 21 \text{ V} = 24 \text{ V}$

$$\begin{aligned}
 \text{d. } P &= I^2 R \Rightarrow I = \sqrt{\frac{P}{R}} = \sqrt{\frac{4 \text{ W}}{1 \Omega}} = 2 \text{ A} \\
 R_1 &= \frac{P}{I^2} = \frac{8 \text{ W}}{(2 \text{ A})^2} = \frac{8}{4} = 2 \Omega \\
 R_T &= 16 \Omega = R_1 + R_2 + 1 \Omega \\
 &= 2 \Omega + R_2 + 1 \Omega \\
 R_2 &= 13 \Omega \\
 E &= IR_T = (2 \text{ A})(16 \Omega) = 32 \text{ V}
 \end{aligned}$$

$$\begin{aligned}
 14. \quad R_1 + R_2 &= 6 \Omega, P_{\text{del}} = P_1 + P_2 \\
 24 \text{ V} \cdot I &= I^2 \cdot 6 \Omega + 24 \text{ W} \\
 I^2 - 4I + 4 &= 0 \\
 I &= \frac{-(-4) \pm \sqrt{16 - 4(1)(4)}}{2(1)} = 2 \text{ A} \\
 \text{and } R &= \frac{P}{I^2} = \frac{24 \text{ W}}{(2 \text{ A})^2} = \frac{24 \text{ W}}{4 \text{ A}^2} = 6 \Omega
 \end{aligned}$$

$$\begin{aligned}
 16. \quad \text{a. } V_R &= 4 \text{ V} = \frac{R(20 \text{ V})}{R + 2 \text{ k}\Omega + 6 \text{ k}\Omega} \\
 4R + 32 \text{ k}\Omega &= 20 R \\
 R &= 2 \text{ k}\Omega \\
 \text{b. } V &= 140 \text{ V} = \frac{(R + 6 \Omega)(200 \text{ V})}{(R + 6 \Omega) + 3 \Omega} \\
 140R + 9(140) &= 200R + 1200 \\
 R &= 1 \Omega
 \end{aligned}$$

$$18. \quad I_{R_2} = \frac{8 \text{ V}}{8 \Omega} = 1 \text{ A}, R_1 = \frac{V_{R_1}}{I} = \frac{8 \text{ V}}{1 \text{ A}} = 8 \Omega, R_3 = \frac{V_{R_3}}{I} = \frac{4 \text{ V}}{1 \text{ A}} = 4 \Omega$$

$$\begin{aligned}
 20. \quad V_{R_2} &= 48 \text{ V} - 12 \text{ V} = 36 \text{ V} \\
 R_2 &= \frac{V_{R_2}}{I} = \frac{36 \text{ V}}{16 \text{ mA}} = 2.25 \text{ k}\Omega \\
 V_{R_3} &= 12 \text{ V} - 0 \text{ V} = 12 \text{ V} \\
 R_3 &= \frac{V_{R_3}}{I} = \frac{12 \text{ V}}{16 \text{ mA}} = 0.75 \text{ k}\Omega \\
 V_{R_4} &= 20 \text{ V} \\
 R_4 &= \frac{V_{R_4}}{I} = \frac{20 \text{ V}}{16 \text{ mA}} = 1.25 \text{ k}\Omega \\
 V_{R_1} &= E - V_{R_2} - V_{R_3} - V_{R_4} \\
 &= 100 \text{ V} - 36 \text{ V} - 12 \text{ V} - 20 \text{ V} = 32 \text{ V} \\
 R_1 &= \frac{V_{R_1}}{I} = \frac{32 \text{ V}}{16 \text{ mA}} = 2 \text{ k}\Omega
 \end{aligned}$$

$$\begin{aligned}
 22. \quad V_{R_3} &= \frac{R_3(60 \text{ V})}{R_3 + 2R_3 + 7R_3} = \frac{R_3(60 \text{ V})}{10R_3} = 6 \text{ V} \\
 V_{R_2} &= 7V_{R_3} = 7(6 \text{ V}) = 42 \text{ V} \\
 V_{R_1} &= 2V_{R_3} = 2(6 \text{ V}) = 12 \text{ V}
 \end{aligned}$$

24. a.  $V_a = +12 \text{ V} - 8 \text{ V} = 4 \text{ V}$   
 $V_b = -8 \text{ V}$   
 $V_{ab} = V_a - V_b = 4 \text{ V} - (-8 \text{ V}) = 12 \text{ V}$
- b.  $V_a = 20 \text{ V} - 6 \text{ V} = 14 \text{ V}$   
 $V_b = +4 \text{ V}$   
 $V_{ab} = V_a - V_b = 14 \text{ V} - 4 \text{ V} = 10 \text{ V}$
- c.  $V_a = +10 \text{ V} + 3 \text{ V} = 13 \text{ V}$   
 $V_b = -8 \text{ V}$   
 $V_{ab} = 21 \text{ V}$
26. a.  $I = \frac{16 \text{ V} - 8 \text{ V}}{10 \Omega + 20 \Omega} = \frac{8 \text{ V}}{30 \Omega} = 0.267 \text{ A (CW)}$   
 $V_a = 16 \text{ V} - I(10 \Omega) = 16 \text{ V} - (0.267 \text{ A})(10 \Omega) = 16 \text{ V} - 2.67 \text{ V} = 13.33 \text{ V}$   
 $V_1 = IR = (0.267 \text{ A})(20 \Omega) = 5.34 \text{ V}$
- b.  $I = \frac{12 \text{ V} + 10 \text{ V} + 8 \text{ V}}{2.2 \text{ k}\Omega + 3.3 \text{ k}\Omega} = \frac{30 \text{ V}}{5.5 \text{ k}\Omega} = 5.455 \text{ mA}$   
 $V_a = 12 \text{ V} - I(2.2 \text{ k}\Omega) + 10 \text{ V}$   
 $= 12 \text{ V} - (5.455 \text{ mA})(2.2 \text{ k}\Omega) + 10 \text{ V}$   
 $= 12 \text{ V} - 12 \text{ V} + 10 \text{ V} = 10 \text{ V}$   
 $V_1 = I(2.2 \text{ k}\Omega) = (5.455 \text{ mA})(2.2 \text{ k}\Omega) = 12 \text{ V}$
28.  $I = \frac{44 \text{ V} - 20 \text{ V}}{2 \text{ k}\Omega + 4 \text{ k}\Omega + 6 \text{ k}\Omega} = \frac{24 \text{ V}}{12 \text{ k}\Omega} = 2 \text{ mA (CW)}$   
 $V_{2\text{k}\Omega} = IR = (2 \text{ mA})(2 \text{ k}\Omega) = 4 \text{ V}$   
 $V_{4\text{k}\Omega} = IR = (2 \text{ mA})(4 \text{ k}\Omega) = 8 \text{ V}$   
 $V_{6\text{k}\Omega} = IR = (2 \text{ mA})(6 \text{ k}\Omega) = 12 \text{ V}$
- a.  $V_a = 44 \text{ V}, V_b = 44 \text{ V} - 4 \text{ V} = 40 \text{ V}, V_c = 44 \text{ V} - 4 \text{ V} - 8 \text{ V} = 32 \text{ V}$   
 $V_d = 20 \text{ V}$
- b.  $V_{ab} = V_{2\text{k}\Omega} = 4 \text{ V}, V_{cb} = -V_{4\text{k}\Omega} = -8 \text{ V}$   
 $V_{cd} = V_{6\text{k}\Omega} = 12 \text{ V}$
- c.  $V_{ad} = V_a - V_d = 44 \text{ V} - 20 \text{ V} = 24 \text{ V}$   
 $V_{ca} = V_c - V_a = 32 \text{ V} - 44 \text{ V} = -12 \text{ V}$
30.  $V_0 = 0 \text{ V}, V_{03} = 0 \text{ V}, V_2 = (2 \text{ mA})(3 \text{ k}\Omega + 1 \text{ k}\Omega) = (2 \text{ mA})(4 \text{ k}\Omega) = 8 \text{ V}$   
 $V_{23} = 8 \text{ V}, V_{12} = 20 \text{ V} - 8 \text{ V} = 12 \text{ V}, \sum I_i = \sum I_o \Rightarrow I_i = 2 \text{ mA} + 5 \text{ mA} + 10 \text{ mA} = 17 \text{ mA}$
32.  $V_L = \frac{3.3 \Omega(12 \text{ V})}{3.3 \Omega + 0.05 \Omega} = 11.82 \text{ V}$   
 $I = \frac{12 \text{ V}}{3.35 \Omega} = 3.58 \text{ A}$   
 $P = I^2 R = (3.58 \text{ A})^2 0.05 \Omega = 0.64 \text{ W}$
34.  $VR\% = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100\%$   
 $V_{FL} = IR = (2 \text{ A})(28 \Omega) = 56 \text{ V}$   
 $VR\% = \frac{60 \text{ V} - 56 \text{ V}}{56 \text{ V}} \times 100\% = 7.14\%$